Surveillance technology and strategy for management of Portugal's EEZ

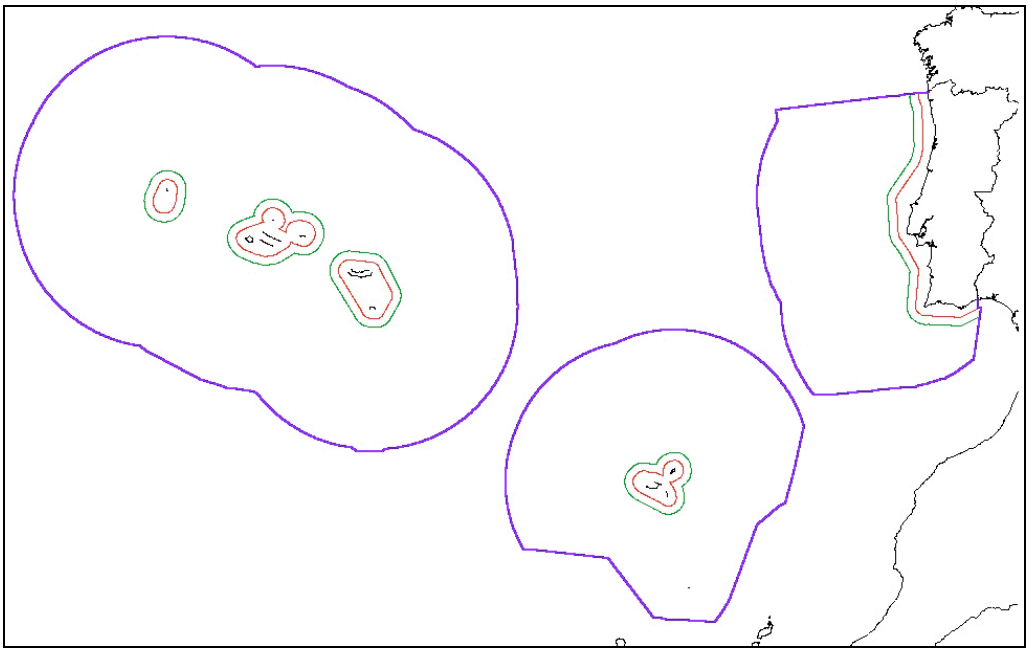
João Joanaz de Melo, Francisco Andrade, Pedro Santana,
Pedro Leitão, Joaquim R. Afonso & João Piedade

1. Introduction

Portugal has an Exclusive Economic Zone (EEZ) of 1.6 million square kilometres, about 18 times the land area, one of the largest in Europe.

The EEZ is one of the zones considered under the United Nations Convention on the Law at Sea (known as Law of the Sea or UNCLOS - 1982). The maritime State has rights and duties on this zone that can be up to 200 miles wide, or even more if we consider the ongoing process of the continental platform "area" definition, under the UNCLOS – PART XI execution agreement, 1994.

The EEZ importance is crucial for economic reasons — fisheries, off shore mining and energy production, archaeology, energy production and tourism, among others — but also for environmental, internal security, defence, geo-strategic and safety at sea issues. Regarding the environment on should emphasise responsibilities under the International Convention for the Prevention of Pollution from Ships (MARPOL). Regarding safety at sea, Portugal is also responsible for two large Search and Rescue Regions (SRR), Lisboa and Santa Maria, under the International Convention for the Safety of Life at Sea (SOLAS, 1974) and the Convention on Maritime Search and Rescue (1979). The institutional boundaries created by such agreements imply different rights and duties and overlap with the existing national institutional boundaries.



[Figure 1 — The Portuguese coastal waters (12 and 24 nautical miles) and EEZ]

Much of the world tanker traffic travels the Portuguese EEZ shipping lanes. Although no precise statistics are available, it is estimated that around on hundred ships per day cross Portuguese coastal waters between Europe and the Mediterranean or Africa. About half of those are tankers. There is a permanent high risk of maritime pollution occurrences that conflict with the other uses of the sea. In Portugal, since 1974, more than 90 maritime pollution incidents took place: 20 had direct coastal impact, originating significant contamination, and five were major accidents resulting in large oil spills. The last such accident, the Prestige wreckage and oil spill, although so far affecting Portugal only marginally (most of the spilled fuel-oil ended up in Galicia) still poses a significant threat because it keeps spilling even at 3000 m of depth. Fisheries, aquaculture and especially tourism may be dramatically affected by such incidents, even at the small scale of operational spills — that make up the majority of marine hydrocarbon pollution and are quite common in the Portuguese coastal waters.

2. Institutional framework

In Portugal, there is currently no national policy or strategy on the Oceans worth speaking of. Responsibilities involving Portuguese oceanic and coastal waters are dispersed among a myriad of institutions, including thirty-odd national agencies from eight ministries (Defence, Agriculture and Fisheries, Environment, Public Works, Economy, Internal Administration, Foreign Affairs, Health), plus the regional governments of Azores and Madeira, dozens of local authorities, private operators (such as port terminals and touristic enterprises), plus the many interests represented by non-governmental organisations.

In short, there is no political institution to co-ordinate Ocean issues, therefore no integrated policy or planning tools to deal with the many problems and conflicts in the Portuguese marine waters. Indeed, many of the values of the EEZ, such as pollution control or mineral extraction, have little pro-active policy or management activities, just a reactive approach whenever problems arise. There are of course sectorial policies conducted by each agency. Each gathers some information to perform its specific brief, but co-ordination among them is scarce, and information exchange is difficult at best, for lack of both technological facilities and coherent procedures.

Maritime surveillance has not been a priority in Portugal, hence available means are insufficient; the responsibilities of a maritime authority are distributed among several institutions, relatively low on State hierarchy and with inadequate co-ordination (as a matter of fact, this is a scenario common in many countries, according to the literature — se e.g. IWCO 1998, Valejo 1994).

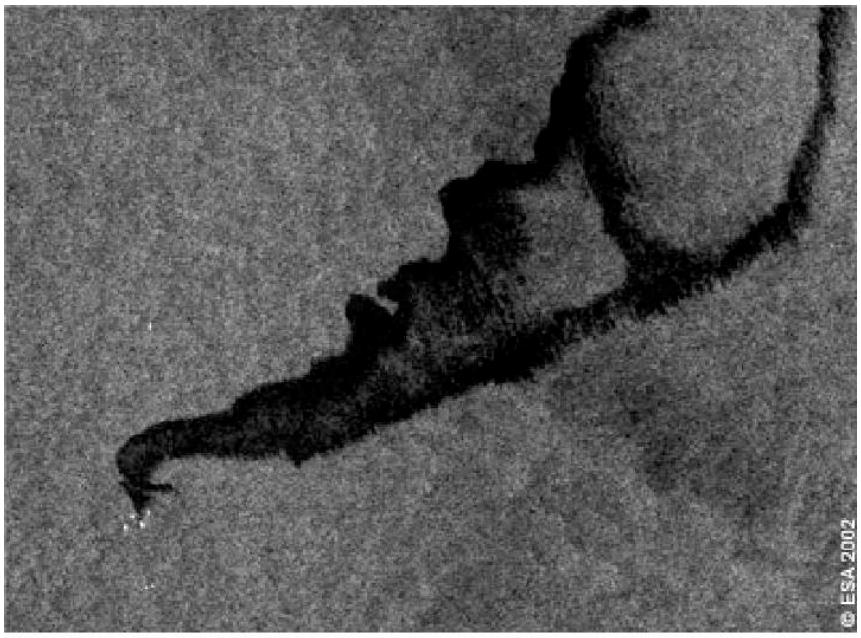
The formal role of maritime authority is committed to the System of Maritime Authority, whose central agency is the Direcção-Geral da Autoridade Marítima, (DGAM) under the Ministry of Defence. However, many of the functions of a maritime authority are in practice performed by other agencies and institutions, such as the operational commands of the Navy and the Air Force, the ports authority (Instituto Marítimo-Portuário, IMP), the border police (Brigada Fiscal da Guarda Nacional Republicana, BF-GNR) and others. Although the essential functions of a

maritime authority are definitely performed, coverage and efficiency are poor and existing means are not used to full capacity, for lack of co-ordination or for lack of adequate funding for current operations (Joanaz de Melo & Santana 2000).

3. Surveillance technology

Managing the EEZ implies first surveillance and control. Current available assets for maritime surveillance in Portugal include the following:

- Aerial reconnaissance by well equipped short-range Aviocar planes, operated by the Air Force, that are mostly used for fisheries control. They do not perform regular maritime lane control missions, due to budgetary constraints, but they can be easily deployed in an emergency, such as happened during the Prestige crisis (indeed, most of the information provided to the local authorities, clean-up teams and the media in Galicia came from Portuguese surveillance);



[Figure 2 — The Prestige oil spill, November 2002. Over 30000 tons of heavy fuel-oil were spilled by the damaged ship. SAR satellite image, courtesy of ESA]

- Aerial reconnaissance by long-range P3 Orion planes of the Air Force. Those are used for anti-submarine warfare and search and rescue operations, but are hardly ever employed for routine marine surveillance due to budgetary constraints;

- Short-range search and rescue operations are performed by land-based helicopters;

- Regular maritime patrol is performed by frigates and patrol ships of the Portuguese Navy. However, most of those ships are well over thirty years old, long overdue replacement, having very poor cost-effectiveness;

- Coastal patrol regarding internal security and crime control (mostly drug related) is performed with fast boats operated by the Navy or the border police (BF-GNR), with support from land-based observation posts with optical devices and short-range radar;

- Harbour approach is controlled by ports authorities with local VTS (vessel traffic services) averaging a range of 25 nautical miles from major ports;

- General oceanographic and fisheries information is gathered by the ships of the Hidrographic Institute of the Navy and the Marine Research Institute of the Ministry of Agriculture and Fisheries, sometimes in partnership with University research projects. They do not, however, perform routine surveillance or resource management duties.

There are other assets in the military and private sectors that might be used in a crisis, such as oceanic tugboats to deliver floating barriers, new frigates with in-board helicopters, or submarines. However, they are not assigned to maritime surveillance.

At present (May 2003) a number of development projects are under way to improve maritime surveillance:

- Acquisition of about ten general-purpose new oceanic patrol ships. One or two of those should specialise in pollution control. The building of the first of these ships has already been contracted, but the whole program has been successively delayed due to budgetary constraints and low political priority. These ships should have the ability to support helicopter refuelling (therefore doubling the range of land-based helicopters at low-cost), but this particular issue is still under study;

- Implementation of the long overdue coastal VTS system, with state-of-the-art radar and communications facilities. This should cover all the continental coastal waters to a distance of 50 nautical miles within two years, and a yet not specified area surrounding the Azores and Madeira later on. Budget is available and the international contest for the equipment was launched over a year ago, but construction has not begun yet due to litigance between the contestants and the Portuguese Government;

- Implementation of differential GPS is under way, although its full potential will not be available until the VTS is operational;

- Acquisition of long-range helicopters, mostly for search and rescue operations, has been under study for years, as yet with no final decision.

Presently there are no official plans for the regular application of other means of surveillance, such as satellite imagery.

In short, Portugal has the know-how to perform maritime surveillance duties, but assets have been less than adequate for the coverage of our EEZ, the existing means are not efficiently used, and overall strategy and co-ordination is rather poor.

4. The InfoZEE project

Overall philosophy

Research on maritime surveillance by the authors led to the development of the InfoZEE concept: an information system for the surveillance and management of the Portuguese EEZ. So far, this has been just a research project, although we do expect it to develop into something more.

The principles underlying the project stem from such international reference documents as the Law of the Sea (UNCLOS 1982) or the IWCO report (1998). It is appropriate to highlight here some points of this emerging philosophy:

- The Oceans are a common heritage of all humankind;
- Ocean resources are scarce and subject to multiple sources of degradation. They have therefore to be cared for and managed. The establishment of a jurisdiction over part of the Ocean carries with it some rights, but also added responsibility;
- Discussion over rights and resource allocation should not be restricted to states, but be a transparent process, open to all stakeholders and to the general public;
- The complexity and inter-relation of the issues at stake recommends an integrated approach to the management of Ocean resources;
- Because there are no borders on the Ocean, for many issues more than formal agreement between parties is needed for meaningful management — effective co-operation is necessary as well;
- Technological and scientific development is essential for Ocean management. We should understand the limitations of our knowledge, try to improve it, and actually use it in decision-making;
- International law should provide means of enforcement. Experience shows dramatically that goodwill alone does not provide any significant release of problems such as hydrocarbon pollution or overfishing;

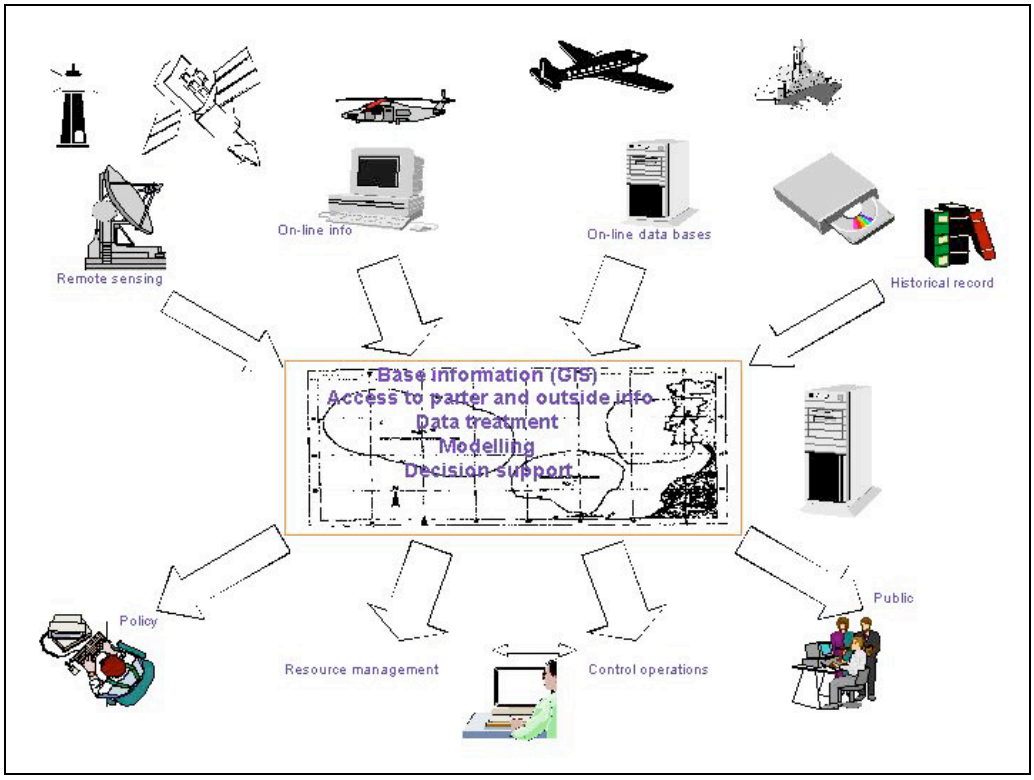
In the specific case of Portugal, we find that many of the necessary assets to follow those principles are either already in place or currently being forwarded by the competent official agencies. What is lacking is:

- Overall strategy and political will;

- Better co-ordination and information exchange among interested agencies;

- Information on some technical issues, such as coastal sensitivity or regular joint use of different surveillance means.

The InfoZEE project was therefore set up to address these hurdles, taking marine pollution control as the first case study. We have researched into specific technical issues, and developed the guidelines for an information system that should provide better information to operational agencies, to decision-makers and to the public. In the following sections, we address the general guidelines of the information system, and the issues of coastal sensitivity, combined use of aerial and satellite surveillance, and the use of transport models.



[Figure 3 — The InfoZEE information system concept.]

The information system

The InfoZEE project proposes a computer-based information system designed to support EEZ management activities, with the following criteria and guidelines:

- Complement and link existing and projected facilities and information sources, rather than duplicate them. Only existing information gaps should be addressed as new information;

- Provide technical staff, managers, planners and decision-makers with a user-friendly tool that improves their performance in practical terms. Since we are dealing with an issue with geographic significance, full use should be made of geographical information systems. Models should also be usable on-line;

- Create information and management tools independent of institutional structure. This means an emphasis on co-ordination and networking rather than centralised control. In fact, the whole system should be able to work through the Internet, based on information exchange among partners according to specific access protocols. A critic aspect is than individual partner systems should be designed for information exchange;

- The system should be used to allow public access to available information, as appropriate. This is very important to raise the public awareness needed to implement proper EEZ management;

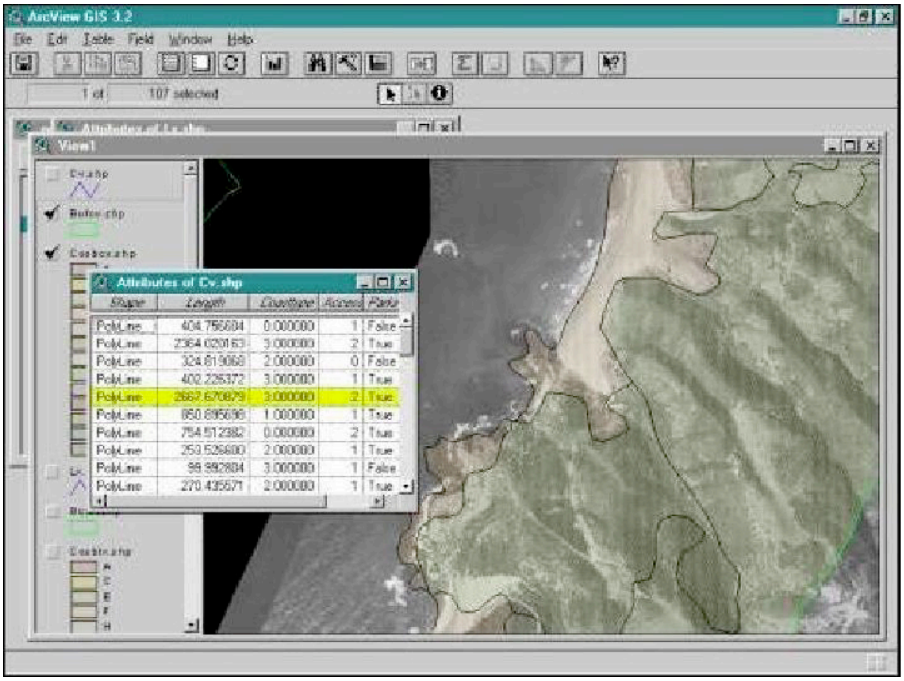
- Sources of information accessible through the system should include: remote sensing either on-line or post-treated from radars, thermal imagers, infrared radars and electro-optical devices, land, ship, air or space based; on-line info from all interested

parties; external databases, including information on shipping, vessel registrars, neighbouring VTS systems, port control records; and regularly updated information such as geographic data.

Coastal sensitivity

The major effects of oil spills are felt when they reach the shore. Accumulation and oiling of large areas – covering at least the whole of the intertidal levels – will occur, with the corresponding impacts: ecological, reflecting the total or partial destruction of the communities impacted (LCM, 1994); social and economic, due to the actual loss of values and resources; mediatic, corresponding to the image and information on the "damages".

Coastal areas impacted by an oil spill may vary from locally restricted to extremely wide and transnational. Yet, even through international co-operation, the availability of countermeasures is always limited. Therefore, the deployment of protection schemes and strategies for a specific incident must take in account a set of priorities based on the actual value of any given shore stretch. In the recent case of the Prestige, whose spill took place out at sea, under extreme weather conditions and for several days, these problems became clear, as the drifting spill threatened both areas of high social value, such as the "Rias Bajas", where bivalve culture is a major economic activity, and of high ecological value, such as the Cies Islands, an important natural reserve in the Galicia coast.



[Figure 4 — Coast line valuation in a geographical information system.]

In view of the above, one of the tasks identified within the InfoZEE project was the development of a "Coastal valuation index" that could be effectively measured for any given shore stretch along the Portuguese coast in order to support decisions in the case of a crisis.

Two contrasting case studies were examined: the highly artificialised Lisbon coast, from the mouth of the Tagus estuary to west of Cascais, to an exposed area already facing West – a highly artificial section, mostly sheltered, where human interventions dominate; and the Southwest, a highly exposed, mostly pristine area classified as Nature Park, with low-density concentrated human occupation.

In order to identify the shore major features, a high-resolution (2 x 2 m^2) photo mosaic was built for both shore sections with a width of 1 km.

To allow for the use of a holistic, ecological economic approach to value the goods and services provided by the coastal environment, including social costs and implications of its loss (Andrade, 1998; Costanza et al., 1999), additional information was added and managed as a GIS where the photo mosaic is the base layer (Joanaz de Melo et al., 2002): ecosystem structure and integrity; resources availability and exploitation; occupation densities and patterns; major economic activities. The impact of any given spill should also be valued (Antunes & Santos, 1998), namely in terms of: reversibility; diversity loss (biological, functional, cultural and social); public health; direct economic cost; time and space scales.

From the joint use of the above criteria, two types of indices can now be produced:

- A sensitivity index for each environment unit – from fragile pristine and highly structured environments, to artificial low diversity environments with low susceptibility and high recovery rates;

- An impact index for each incident – from short-term and small-scale easily reversible low impact incidents, to large-scale, permanent and highly impacting incidents.

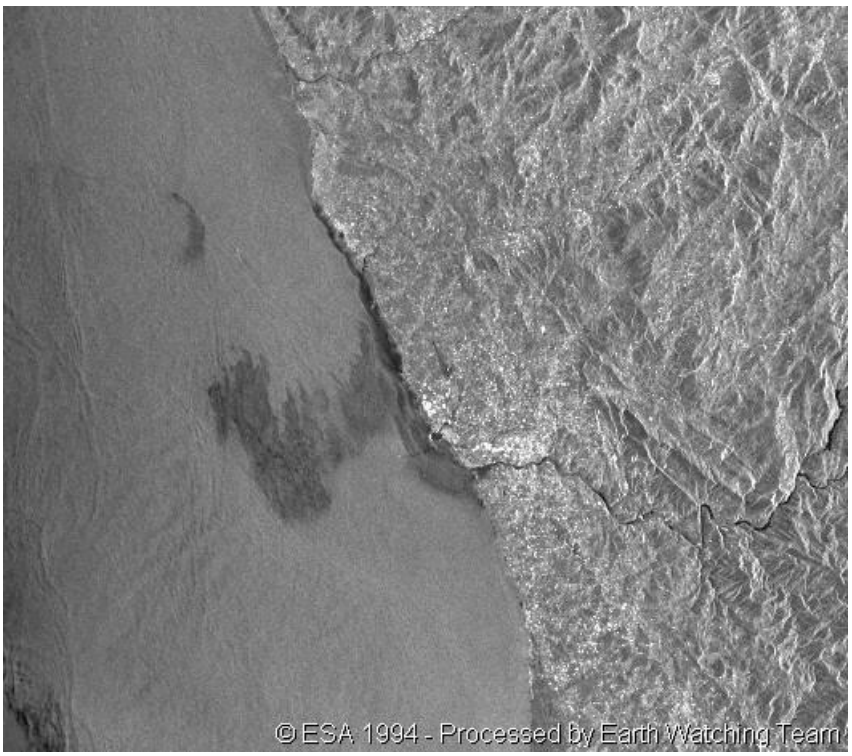
Combined satellite and airborne maritime surveillance

The surveillance of the Portuguese Exclusive Economic Zone has been conducted with airborne and naval patrolling units, which is insufficient and not cost-effective. Today, satellite surveillance, for a number of goals including traffic and pollution control, has become feasible. Space-borne synthetic aperture radar (SAR) has become a very popular tool for ocean oil slick monitoring due to its wide coverage in all weather conditions, day and night.

The EEZ surveillance can be highly improved if we can clearly define a mapping grid for combined satellite and airborne detection. In order to achieve such optimisation we have to consider several issues: available satellite information, SAR radiometric calibration, raw data quality parameters, necessary satellite resolution, relation between the dimension of a spill and its effective impact on a coast, analysis of recent spills for cross-referencing, clarification of the false negative and false positive ambiguity, co-ordination between satellite and airborne surveillance, and definition of an action plan on detecting a spill.

The goal of this line of research is to define clearly the type and amount of information — and the budget — necessary to cover the whole Portuguese EEZ, including the frequency of observations and the resolution needed for each grid element, depending on average weather conditions, distance to sensitive regions and

traffic intensity. A literature review shows a lot of information and expertise on the use of such techniques, but mostly in coastal or confined waters, such as the North Sea and the Mediterranean, which are smaller and somewhat different from the conditions we get in the open Atlantic.



[Figure 5 — October 1994. The oil tanker *Cercal* struck a rock while entering the harbour of Leixões, near Oporto, Portugal, spilling about 1000 tonnes of crude oil. SAR satellite image, courtesy of ESA.]

Using marine transport models

Over the past two decades, intensive research was made toward the development of mathematical models to predict and forecast the fate and transport of spilled oil in the marine environment. A large number of oil spill models are in use in the world today. They range in capability from simple trajectory, or particle tracking models, to three–dimensional trajectory and fate models that include simulation of response actions (Reed et al., 1999). Response measures are enhanced by a rapid and accurate prediction of the fate and transport of the spilled oil. To achieve an effective response, it is important to track the oil and to know is condition; it may be too thin to skim or too viscous to disperse (Sebastião & Soares, 1995).

Existing oceanic transport models, namely those used by the Portuguese Navy and Universities, are adequate to medium term predictions (hours to days) or to backtrack a detected oil spill to its origin. However, they are too heavy and not user friendly enough for a good short-term emergency response, such as is sometimes necessary when dealing with an oil spill or planning search and rescue missions.

This line of research is therefore focused on the use of user-friendly on-line models, that may gather information automatically from Internet sites, or input immediately available qualitative information, and give immediate if crude answers to support urgent decisions.

Conclusion

Portugal has a strategic interest in the Oceans that has not materialised so far in a good control or management of its coastal or oceanic waters. Maritime surveillance has been improved and most of the relevant know-how already exists, but more effort must be made in terms of national policy, inter-agency co-ordination, public information and capacity building.

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The authors

João Joanaz de Melo: PhD in Environmental Engineering, New University of Lisbon, 1992. Assistant Professor at the Department of Environmental Science and Engineering, New University of Lisbon. Teaches Environmental Impact Assessment and Environmental Management. Co-ordinator of Project InfoZEE.

Francisco Andrade: PhD in Ecology, University of Lisbon, 1986. Assistant Professor at the Department of Zoology, University of Lisbon. Teaches Remote Sensing and Biological Oceanography. Director of the Marine Laboratory of Guia, University of Lisbon. Co-ordinator of research projects on coastal management in Portugal.

Pedro Santana: graduate student at the Masters program on Statistics and Information Management, New University of Lisbon. His research is focused on the analysis of information systems supporting maritime surveillance for marine pollution control.

Pedro Leitão: MSc in Environmental Remote Sensing, University of Aberdeen, Scotland, UK, 2000. Research assistant at IMAR. Research interests: remote sensing and GIS applied to Ecology, Landscape Ecology and Coastal Management.

Joaquim Rocha Afonso: Portuguese Navy officer; graduate student at the Masters program on Marine Science, New University of Lisbon. His research is focused on the optimisation of maritime surveillance with combined aerial and satellite assets.

João Piedade: Portuguese Navy officer; graduate student at the Masters program on Marine Science, Technical University of Lisbon. His research is focused on the use of Internet-based real-time dispersion models for pollution control and S&R.